Presentation Outline

- References
- Electrochemistry
- International system of Physical quantity
- Electrochemical Processes
- Faraday's Laws

References

1- Physical chemistry Gordon . m. barrow

٢- الكيمياء الكهربائية د. جلال محمد صالح

٣- الكيمياء الكهربائية د.ادمون ميخائيل

Electrochemistry

Electrochemistry science is

1- The science which studies transformation of chemical energy into electrical energy and vice versa.

2- The science which deals with the consequence of the transfer of electric charges from one place to another

3- The study of the relationship between chemical and electrical change. Electrochemical science has a multitude of applications, ranging from solar technology to biomedical innovations.

International system

Physical Quantity	Name of Unit	Unit Symbol	Unit Expressed In terms of Base Units
Force	Newton	N= F= mass x 9.8 $m.s^{-2}$	$Kg.m.s^{-2}$
Energy	Joule	J= F x d	N.m or Kg $.m^{2}.s^{-2}$
Power	Watt	W= J x s^{-1}	$J.s^{-1}$
Quantity of electricity	Coulomb	C	A.s
Electromotive force	Volt	V= J/ C	$J.A^{-1}.s^{-1}$ or w $.A^{-1}$
Electro resistance	Ohm	Ω= V/A	$V.A^{-1}$ or J $.C^{-1}$. A^{-1}
Electric conductance	Siemens	S	$Ω^{-1}$
Electrical capacitor	Farad	F= C/V	A. s. v^{-1}
Current density	Current	i	$A.cm^{-2}$
Current	Amper	I	A

Electrochemical Processes

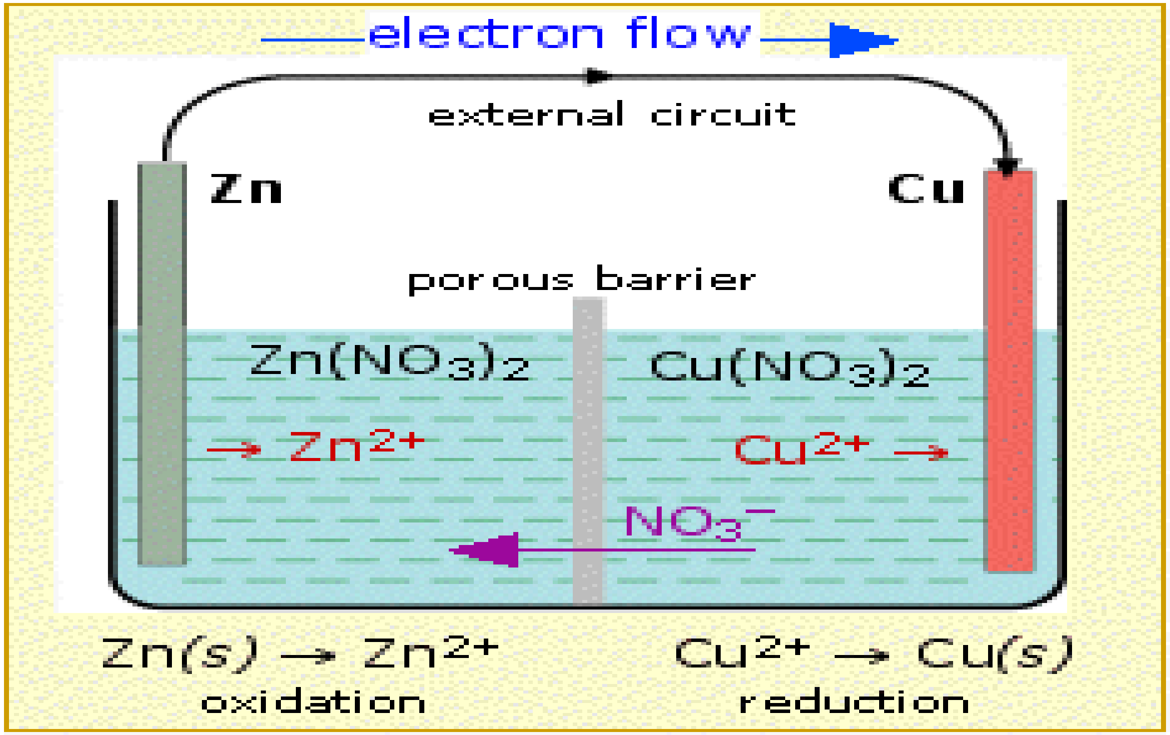
Any electrochemical reaction involves passage a current through the electrodes and solution

Reduction Processes

The term refers to the element that accepts electrons, as the oxidation state of the element that gains electrons is lowered.

Oxidation Processes

The opposite process is called reduction, which is the loss of electrons. It happens when an atom or compound loses one or more electrons



$$Cu^{+2} + 2e \xrightarrow{\text{reduce}} Cu^{\circ} \downarrow$$ (Reduction Process) (cathode)

$$Zn^{\circ} \xrightarrow{\text{oxide}} Zn^{+2} + 2e$$ (Oxidation Process) (anode)

Faraday's Laws

Faraday's First Law

The amount of substance which reacted at the electrodes is directly proportional to the quantity of electricity which has passed through the solution.

$Q \ \alpha \ W$

$Q = It$

$W \ \alpha \ It$

$W = E_e It$

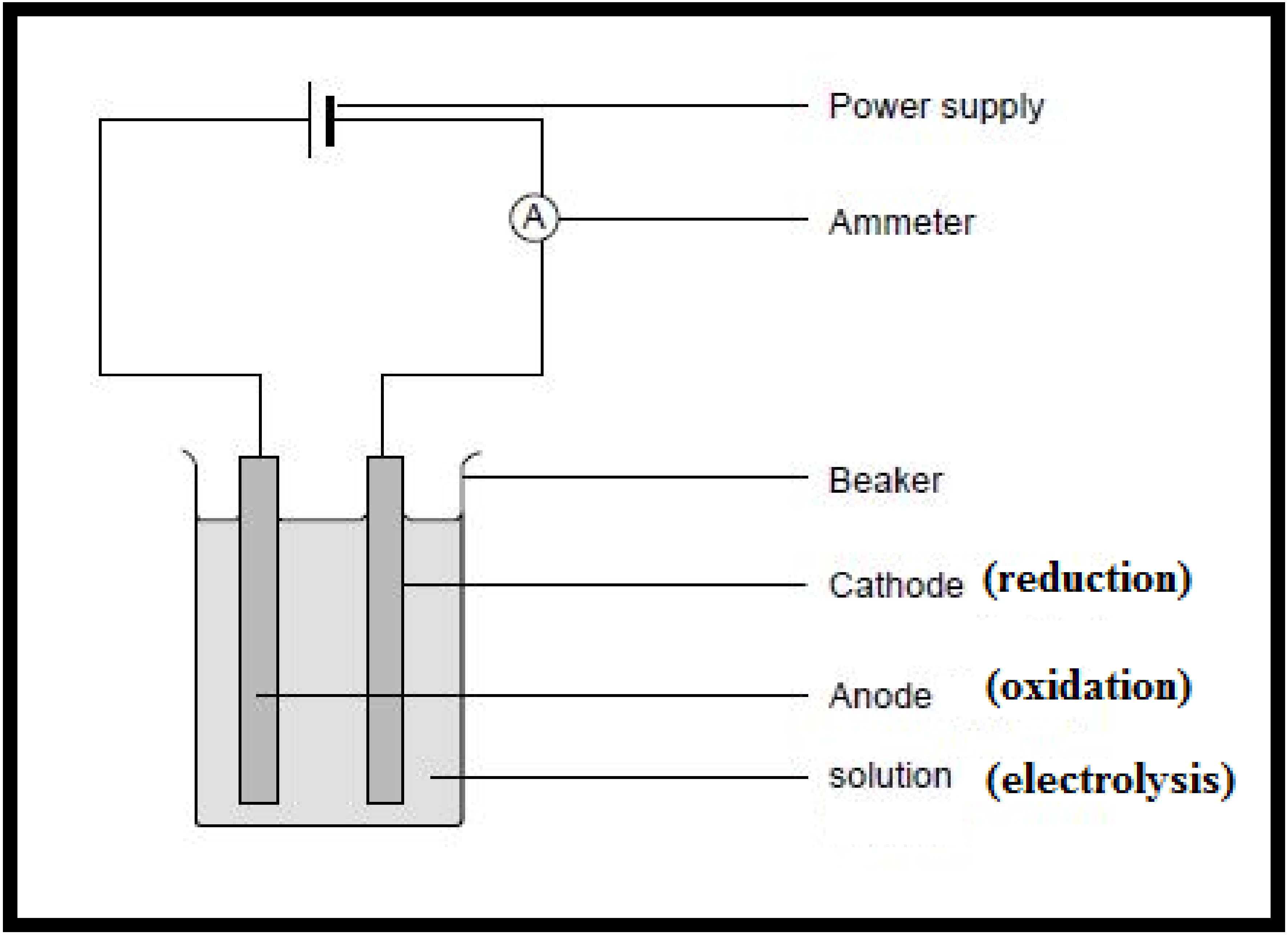
where ***W*** **is weight of chemical change at an electrode (g)**

Q is the amount of electricity (C)

I is the intensity of current (Ampere)

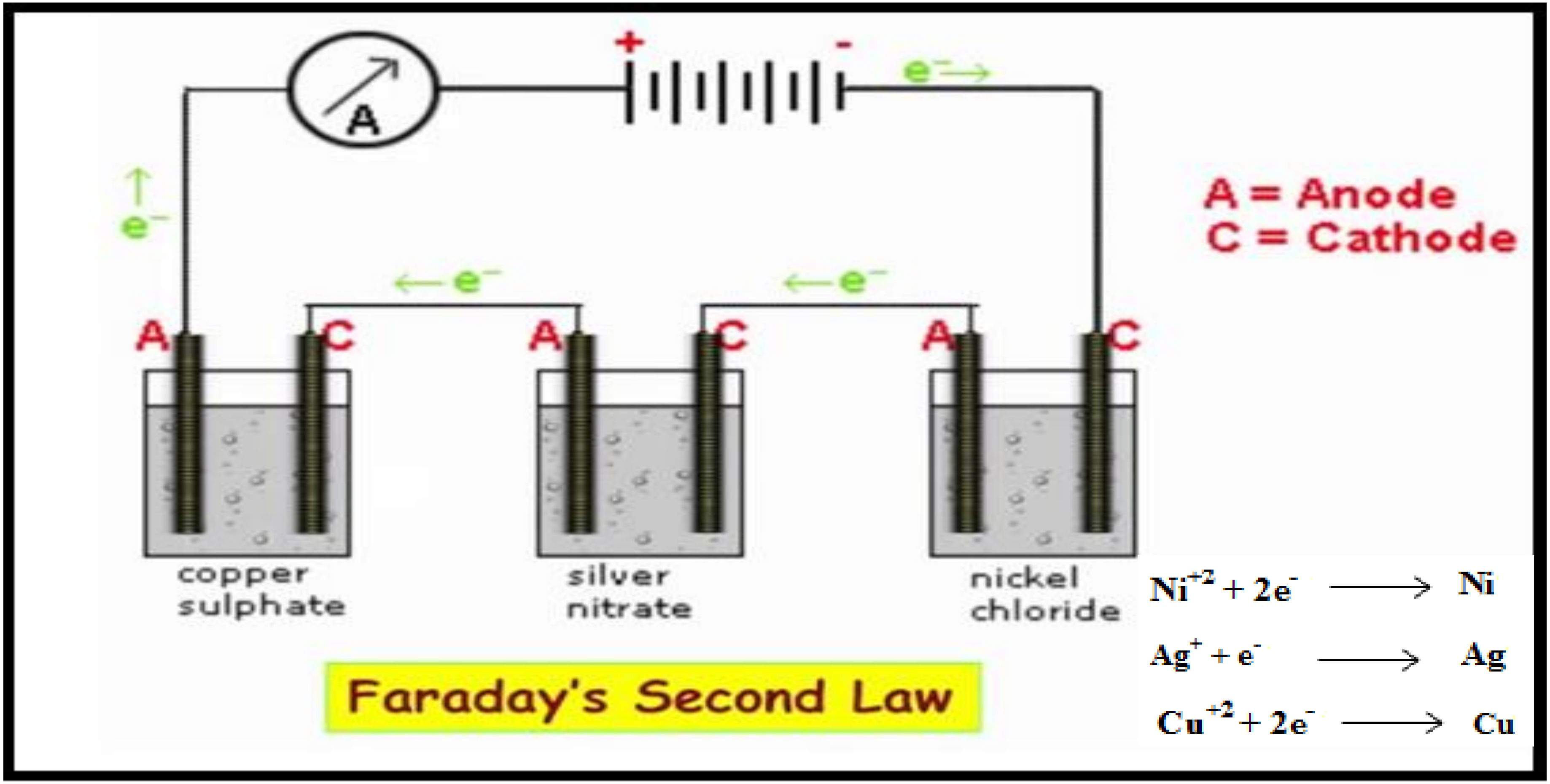
t is the time (s)

E_e is electrochemical equivalent


Power supply
A
Ammeter
Beaker
Cathode (reduction)
Anode (oxidation)
solution (electrolysis)

Faraday's Second Law

When the same quantity of electricity is passed through different electrolytes, the mass of various substances which reacted or deposited at the electrodes is directly proportional to the chemical equivalent or equivalent weight of these substance.



W α e

Chemical Equivalent (e) = Atomic Weight / valence

$$e = \frac{M}{z}$$

Q/ Calculate the chemical equivalent of Cu^{+2}, Ag^{+1}, H^{+}. If you know the atomics weights of the cations respectively are 63.6, 107.9, and 1.008

$$e = \frac{M}{z} = \frac{63.6\ g/eq}{2} = 31.8\ g/eg \quad (\text{for } Cu^{+2})$$

$$e = \frac{M}{z} = \frac{107.9\ g/eq}{1} = 107.9\ g/eg \quad (\text{for } Ag^{+1})$$

$$e = \frac{M}{z} = \frac{1.008\ g/eq}{1} = 1.008\ g/eg \quad (\text{for } H^{+})$$

Link between first and second lows of Faraday's

as

$W \alpha Q$..........(From Faraday's first Low) ..... (1)

$W \alpha e$ ....(From Faraday's second Low).....(2)

Therefore

$W \alpha Qe$ ....(3)

as $Q = It$

therefore

$W \alpha Ite$ ....(4)

as $e = \frac{\mu}{z}$ ....(5)

after change the α to the constant

$$W = \bar{K} It \frac{\mu}{z} \qquad (6)$$

$$\bar{K} = \frac{1}{F} = \frac{1}{96485}$$

$Q = C = A.s$

So

$$W = \frac{It\mu}{FZ} \qquad (7)$$

$$W = \frac{Q\mu}{FZ} \qquad (8)$$

Q1/ How many coulombs are required for the following reduction

1- 1 mole of Al^{+3} to Al

2- 1 mole of Cu^{+2} to Cu

Sol/

1- w= $\frac{QM}{FZ}$

Q= $\frac{W\,(g)\,.\,F\left(\frac{C}{mole}\right).\,Z}{M\,(\frac{g}{mole})}$ **= 1 mole x 96485 x 3 = 289455C (Al^{+3} to Al)**

Q2/ How many coulombs are required to 50gm of Al from molten Al_2O_3? If you know the Atomic Weight of Al = 27.

sol/ $w = \frac{QM}{FZ}$

$$Q = \frac{W\,(g)\,.\,F\left(\frac{C}{mole}\right).\,Z}{M\,\left(\frac{g}{mole}\right)} = \frac{50\,(g)\,x\,96485\left(\frac{C}{mole}\right)\,x\,3}{27\left(\frac{g}{mole}\right)} = 536027\ C$$

Q3/ $Ni(NO_3)_2$ solution is electrolyzed between pt electrodes using a current of 5.0 Ampere for 30 minutes. What is the Weight of Ni will be produced at the cathode? If you know the atomic Weight of Ni =58.69 g/mole.

Sol/ $w = \frac{QM}{FZ}$

Q= It= 5 A x 30x60 s= 9000C

$$w = \frac{9000C\ X\ 58.69\left(\frac{g}{mole}\right)}{96485\ X\ 2} = 2.737\ g$$

Q4/ The current passage was 15A through silver nitrate solution for 10 min that required to precipitate 9.9gm silver. What is the current efficiency? If you know the atomic Weight of Ag= 108 g/mole.

- **Sol/** w= $\frac{QM}{FZ} = \frac{ItM}{FZ}$
- W= $\frac{15\ A\ X\ 10\ x\ 60S\ X\ 108\left(\frac{g}{mole}\right)}{96485\left(\frac{C}{mole}\right)X\ 1}$ = 10.07 g (theoretical value)

Efficiency= $\frac{9.9\ g}{10.07\ g}$ x100= 98.4%

Homework

Q5/ The current passage was 0.1A through $CuSO_4$ solution for 10 min at 25C^{o}, if used pt electrode as cathode. If you know the atomic Weight of Cu= 63.5 g/mole.

- **Calculate copper weight at cathode?**
- **Calculate Oxygen volume is released at anode at 740 mmHg?**

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